International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 12 | Dec 2021 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON CONCRETE WITH PARTIAL REPLACEMENT OF HYPO SLUDGE IN CEMENT

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Abstract: The global cement industry contributes about 9% of greenhouse gas emission to the earth's atmosphere and industrial wastes are being produced by 420 million tonnes per annum by chemical process in India. In order to reduce cement manufacturing and disposal problem of paper waste, there is a need to develop alternative binders in construction field. Utilization of industrial waste products as Supplementary Cementitious Material (SCM) in concrete is very important aspect in view of economical, environmental and technical reasons. This work examines by using paper waste (hypo sludge) as partial replacement of cement & it is most essential to develop profitable building materials from hypo sludge. It is directed towards developing low cost concrete and light weight concrete from paper industry waste. The use of hypo sludge in concrete. These tests were carried out to evaluate the mechanical properties like compressive strength and spilt tensile strength and flexural strength up to 7 days, 14 days and 28 days. In this work, M25 grade concrete was developed by replacing cement via 10%,15%,20%,25% and 30% of hypo sludge. The strength on concrete made with hypo sludge are compared with normal concrete. Industrial wastes are being produced per annum by chemical and agricultural process in India. These materials possess problems of disposal and health hazards. The wastes like phosphogypsum, fluorogypsum, hypo-sludge and red mud contain obnoxious impurities which adversely affect the strength and other properties of building materials based on them. To reduce disposal and pollution problems emanating from these industrial wastes. it is most essential to develop profitable building materials from them. This project is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement.

Keyword's: Hypo Sludge, Compressive strength, partial replacement

1. INTRODUCTION

Paper trash (hypo sludge) is a by product of the paper and board manufacturing industry. Paper waste is projected to account for 0.7 percent of total urban waste created in India. The paper industry has a serious economic and environmental dilemma in the form of paper sludge. Strong and weak fibres can be found in paper sludge. The strong waste fibres are used in the recycling process to generate recycled paper, while the weak waste fibres are disposed of. As a result of this disposal, there is a serious problem with air, water, and soil pollution. Paper sludge is being replaced with cement to reduce the disposal problem. Paper waste acts like cement due to its silica and magnesium characteristics, which enhances the setting time of cement..

Hypo sludge was first introduced as an artificial pozzolana, including a small quantity of silica, magnesium, and a significant amount of lime, which is the primary property of cement. The mechanical, physical, and chemical features of hypo sludge, which is utilised as a replacement in the production of mortar, were examined. The use of waste materials instead of raw materials will save resources and prevent environmental and ecological damage caused by quarrying and exploitation of raw materials for cement production. There is an increasing need for low-cost concrete around the world; by making this concrete, the demand for concrete will be reduced, and CO2 emissions from the cement sector will be reduced. This project describes the technical and environmental benefits of using supplemental cementitious materials and investigates the design parameters of concrete when paper waste is used as a partial replacement for cement.

Some businesses incinerate their sludge, contributing to our major air pollution concerns. It is critical to generate lucrative construction materials from these industrial wastes in order to address disposal and environmental issues. With this in mind, experiments were conducted to generate low-cost concrete by combining various cement-to-hypo sludge ratios. Paper production

generates a significant amount of solid waste. Paper fibres can only be recycled so many times before they become too short or weak to be used to manufacture high-quality paper.

1.2 Hypo Sludge

One of the by-products of the paper industry is hypo sludge. The utilisation of these by-products has environmental benefits in that it diverts material from the trash stream, reduces energy consumed in processing virgin resources, and reduces pollution. Despite a dramatic surge in the previous three to four years, India is a resourceful country in terms of industrial waste generation, with an annual output of over 300 million tonnes. However, utilisation remains below 20%. Consistently high-quality Hypo sludge is widely available, and people are aware of the benefits of using it in concrete.

Figure 1. Hyposludge

1.3 Need For Hypo Sludge Utilization.

Various wastes emerge from the various processes in the paper industry during the manufacturing of paper. Our project uses hypo sludge, a preparatory waste with minimal calcium, to replace cement in concrete. Greenhouse gases are discharged into the atmosphere as a result of cement manufacture. 1 million T of greenhouse gases are released in the production of 4 million T of cement. Furthermore, in order to minimise environmental degradation, this sludge was not disposed of in large quantities on land.

1.4 OBJECTIVES

- To investigate the utilization of Hypo Sludge as Supplementary Cementitious Material (SCM) and influence of this hypo sludge on the Strength of concrete.
- Influence on the cost of concrete made with different Cement replacement levels.
- To study the suitability of supplementary cementitious materials (SCMs) like hypo sludge.
- To find out the optimum percentage of hypo sludge in concrete in the place of cement.
- To compare the compressive strength of conventional concrete with hypo sludge concrete.
- To compare the cost of conventional concrete with hypo sludge concrete.

2. LITERATURE REVIEW

Pera J et.al (1998) Burnt paper sludge has greater pozzolanic activity than commercially available metakaolin, while having a lower kaolinite content, especially at young ages. (109)

Ishimoto H. et.al (2000) According to the research, efforts to effectively recycle paper have resulted in an annual increase in the amount of papermaking sludge discharged throughout Japan, with current estimates of about 3,000,000 tonnes discharged yearly. By reacting ash generated from cremated papermaking sludge in an alkali solution, the Nippon Telegraph and Telephone Corporation has succeeded in turning ash derived from incinerated papermaking sludge into a novel porous material with high caution exchange capacity. The novel material's application could be in environmental conservation, such as water quality enhancement and concrete admixture..

Albinas Gailius et.al (2003) Workability and strength of concrete prepared using various amounts of waste paper sludge ash (WSA) and ground granulated blast furnace slag (GGBS) as binder, at two w/b rations of 0.5 and 0.4, were examined. The rate of development of strength of concrete formed with WSA-GGBS binder was roughly 2-6 percent of its 28-day strength on the first day, and 53-64 percent of the 28-day strength on the seventh day concrete.

J. Bai et.al (2003) At a water to binder (w/b) ratio of 0.5, the compressive strength and hydration characteristics of wastepaper sludge ash-ground granulated blast furnace slag (WSA-GGBS) blended pastes were examined. The best combination for maximal strength was 50 percent WSA-50 percent GGBS, and pastes made from this blend have

compressive strengths that are close to 50 percent that of a comparable Portland cement paste after 90 days. (12)

T.R. Naik etal (2003) To improve the strength, durability, and life span of concrete structures exposed to the elements, researchers recommend incorporating fibrous residuals from mills into ready-mixed concrete. The life span j of high-performance concrete, dubbed "cellucrete" by researchers, might increase from the usual 25 to 35 years to up to 100 years. (92,94)

Ritzawaty binti Mohamad Shukeri etal (2008) reported on the findings of an experiment into the use of wastepaper as an extra material in waste-containing concrete mixes (control mix). ' 5 percent, 10%, and 15% more ingredients to concrete were made with weight ratios of 1:2:3 for cement, sand, and aggregate, respectively. The mechanical strength was drastically reduced when 25% wastepaper was added in proportion to the amount of cement: Overall, the density and strength of concrete containing paper were shown to be highly correlated. In general, the compressive strength, tensile strength, and flexural strength of concrete declined as the amount of wastepaper increased in each set of concrete mixes including wastepaper. The concrete mix containing 5% wastepaper had higher tensile and flexural strength than the control mix.

3. METHODOLOGY

3.1 MATERIALS

Cement, sand, cement coarse aggregates, hypo sludge, and water are some of the materials utilised in the manufacture of concrete**.**

3.1.1 CEMENT

Cement is created by finely grinding calcined limestone and clay into a grey powder. Cement is one of the project's binding agents. The cement and water combine to form a paste that binds the other ingredients. The cement used is Ordinary Portland Cement (53 grade) that meets IS:8112-1989 specifications. On cement, numerous tests were carried out.

Figure 2. Cement

3.1.2 FINE AGGREGATE

Clean river sand with a maximum size of 4.75mm, adhering to Zone I of IS 383-1970, was used as fine aggregate throughout the project. Sand is a granular material made up of finely fragmented rock and mineral particles that occurs naturally. The physical parameters of fine aggregate are examined in line with IS:2386, including specific gravity, fineness modulus, and water absorption.

Figure 3 Sand

3.1.3 COARSE AGGREGATE

Crushed granite or basalt rock, according to IS:383, is used to make coarse aggregate. The coarse aggregate utilised is 20mm in size. Specific gravity, fineness modulus, and water absorption properties of coarse aggregate are examined in line with IS:2386.

Figure 4. Coarse aggregates

3.1.4 HYPOSLUDGE

Hypo sludge is a waste product originating in the paper industry. Because of its silica and magnesium content, hypo sludge behaves like cement. It is an excellent

concrete binding chain material. The chains also pack consistently in areas, forming a hard, stable crystalline region that adds even more stability and strength to the bundle chains. In concrete, hypo sludge is used to replace 10 percent, 15 percent, 20 percent, 25 percent, and 30 percent of the cement. The compressive strength and spilt tensile strength were also measured after 7 and 28 days, respectively.

One of the by-products of the paper industry is hypo sludge. The utilisation of these by-products has environmental benefits since it diverts the material from the trash stream, reduces the energy required to process virgin materials, and reduces pollution. Despite a dramatic growth in the previous three to four years, India is a resourceful country for the generation of industrial wastes, with an annual output of over 300 million tones. However, utilisation remains below 20%. Availability of high-quality Hypo sludge across the country, as well as knowledge of the benefits of employing Hypo sludge in concrete.

Figure 5. Hypo sludge

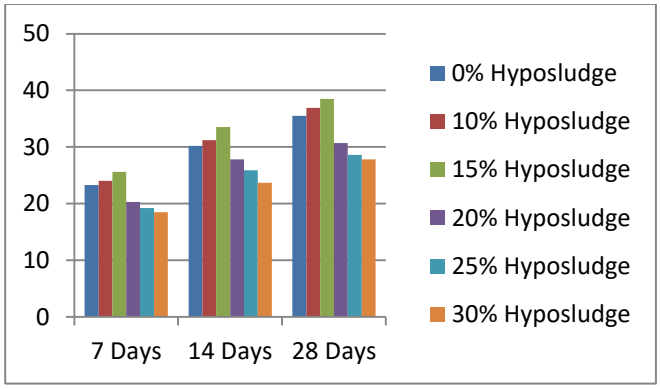
4. RESULTS AND DISCUSSIONS

4.1 Test Results of Compressive Strength for M25 Grade Concrete

The compressive strengths of the casted cubes were evaluated at 7 days, 14 days, and 28 days, and the findings are listed below. Concrete made with hypo sludge cement. The tests were carried out in accordance with IS 516-1959. Compressive strength was determined using cubes of standard dimension of 150150150mm. Cubes were placed on the UTM surface, and a uniform rate of loading was applied until the cubes failed. The maximum load was calculated and recorded.

Table 1 : Compressive strength of Hypo sludge cement concrete

SNO	Sample	% of Hypo sludge cement	Compressive strength in N/mm2 7 Days	Compressive strength in N/mm2 14 Days	Compressive strength in N/mm2 28 Days
1	H1	0	23.3	30.2	35.5
2	H2	10	24	31.2	36.9
3	**H3**	**15**	**25.6**	**33.5**	**38.5**
4	H4	20	20.3	27.8	30.7
5	H5	25	19.2	25.9	28.6
6	H6	30	18.5	23.7	27.8



Graph 1. Compressive strength of concrete

Result: It is seen from the Graph that the Hypo sludge cement concrete given Maximum Compressive strength at 15 % of Hypo sludge cement which is 38.5 N/MM2

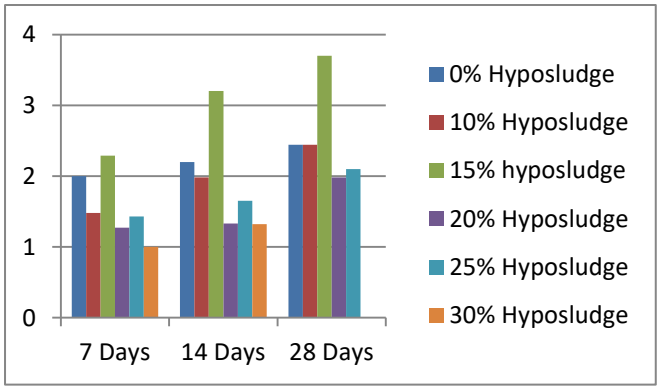
4.2 Split tensile strength

The split tensile test is used to determine concrete's tensile strength. The split tensile test was performed on cylinders with a diameter of 150mm and a height of 300mm. Cylinder specimens' split tensile strength is evaluated by inserting them between the two plates of a Compression Testing Machine. This test was carried out in accordance with IS 5816-1970. On the UTM with the horizontal diameter, a cylinder of standard size of

150mm dia and 300mm height was set. Two strips of wood were added at the bottom and top of the CTM to prevent concrete crushing at the points where the bearing surface of the CTM and the cylinder specimen contact. The maximum load was jotted down on a piece of paper.

Table 2 : Split tensile strength of Hyposludge cement concrete

SNO	Sample	% of Hyposludge cement	Split tensile strength in N/mm2	Split tensile strength in N/mm2	Split tensile strength in N/mm2
			7 Days	14 Days	28 Days
1	H1	0	2	2.2	2.44
2	H2	10	1.48	1.98	2.44
3	**H3**	**15**	**2.29**	**3.2**	**3.7**
4	H4	20	1.27	1.33	1.98
5	H5	25	1.43	1.65	2.1
6	H6	30	1	1.32	1.49



Graph 2: Split tensile strength of concrete

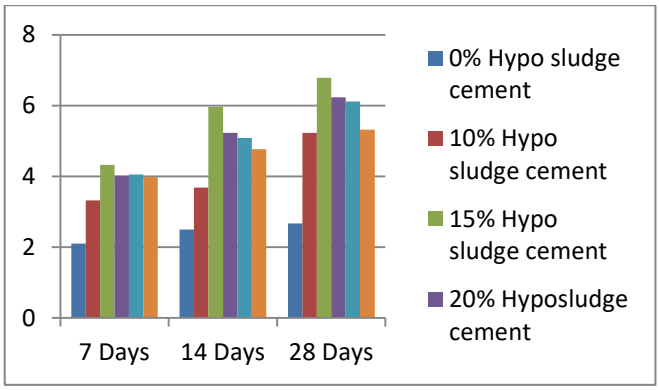
Result: It is seen from the Graph that the Hypo sludge cement **concrete** given Maximum tensile strength at 15% of Hypo sludge cement which is 3.7 N/mm2

4.3 Flexural Strength

The standard beam specimen of size 100x100x500 mm was supported symmetrically over a span of 400 mm for the flexural test on Hyposludge cement concrete. At 28 days after adding hyposludge and cement, the average flexural strength of Hyposludge cement concrete was measured. This test was carried out according to the ASTM C-78 technique, with centre loading used to determine the flexural strength. The test specimens were cast using standard cast iron moulds. Machine oil was placed on the interior surfaces of moulds before casting. A horizontal pan mixer machine was used to mix geopolymer concrete with glass fibres, which was then poured into the moulds in stages. A table vibrator was used to compact each layer of concrete.

Table 3. Flexural Strength of Geopolymer concrete by using Glass fibre

SNO	Sample	% of Hypo sludge cement	Flexural strength in N/mm2	Flexural strength in N/mm2	Flexural strength in N/mm2
			7 Days	14 Days	28 Days
1	H1	0	2.1	2.5	2.67
2	H2	10	3.32	3.68	5.23
3	**H3**	**15**	**4.32**	**5.96**	**6.78**
4	H4	20	4.02	5.23	6.23
5	H5	25	4.05	5.08	6.11
6	H6	30	3.98	4.77	5.32



Graph 3. Flexural strength of concrete

Result: It is seen from the Graph that the Hypo sludge cement concrete given flexural strength at 15 % of Hypo sludge cement which is 6.78 N/mm2

5. CONCLUSIONS

Finally, we complete our experiment by partially replacing cement with hypo sludge and curing various mixes for 7 days, 14 days, and 28 days. In a compression testing machine with a capacity of 1000 kN, cubes and cyclinder are tested. The compressive strength of concrete improves as the curing duration for M30 grade concrete grows, and the replacement of hypo sludge is increased from 0%, 10%, 15%, 20%, 25%, and 30%. For 15% cement replacement, the maximum compressive strength is achieved for 7 days, 14 days, and 28 days, and then the strength begins to decline from 20% to 30%. For 15% cement replacement, the maximum spilt tensile strength is achieved for 7 days, 14 days, and 28 days, and then the strength starts to decline from 20% to 30%. For 15% cement replacement, the maximum flexural strength is achieved for 7 days, 14 days, and 28 days, and then the strength starts to decline from 20% to 30%. In comparison to ordinary concrete, the strength of the concrete is achieved by replacing 15% of the hypo sludge with cement.

As per relevant IS-code practice based on the test results obtained from this study the following conclusion can be drawn.

- From the compressive strength test results, it is found that the higher strength is observed for the conventional concrete.
- There is strength reduction with the addition of Hypo Sludge due to the impurities present in Hypo Sludge like free lime, loss on ignition and other raw minerals.
- However the strength attained with the mix of Hypo Sludge complies with the target strength up to a replacement of 15%.
- When the SF addition is greater than 15%, the strength produced by the concrete gets reduced than the target strength.

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- 2013 • ISSN No 2277 - 8160